

# **Results of Rotary Auger Trap Sampling in the Nanaimo River, 1999**

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**by**

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## ABSTRACT

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In 1999, a study of juvenile chinook salmon (*Oncorhynchus tshawytscha*) productivity was conducted by Fisheries and Oceans Canada, Pacific Biological Station together with the Nanaimo First Nations. The three key elements of this yearly project are: i) enumeration of juvenile out-migrants, ii) monitoring growth of hatchery and naturally-reared fry, iii) monitoring hatchery releases and interaction between hatchery and naturally-reared fry in the river. A rotary screw trap was used to estimate fry production. Bismarck Brown dyed naturally-reared fry were released above the trap site and recapture results of these marked fry were used to expand trap catches to estimate total production. The minimum estimate of production of naturally-reared juvenile chinook for the 1998 brood year was 25,424 (95%CL: 22,822 - 27,966). Minimal recapture data were obtained from hatchery fry. A total of 1,691 hatchery fry were recovered from three hatchery fry releases which occurred (May 9, 12 and 13) while the project was active. It was assumed that these hatchery fry emigrated out of the river shortly after release and those that remained in the river for a period of time did not migrate down to the trap site prior to the end of the project. The other hatchery release (May 28) occurred after the project completion. It is believed therefore that hatchery and naturally-reared fry interaction is minimal. Based on hatchery records, releases of chinook fry and smolts in 1999 totalled 608,425.

## RÉSUMÉ

Nagtegaal, D. A. and E. W. Carter. 2000. Results of rotary auger trap sampling in the Nanaimo River, 1999. Can. Manuscr. Rep. Fish. Aquat. Sci. 2502: 24 p.

En 1999, la Station de biologie du Pacifique de Pêches et Océans Canada, en collaboration avec les Premières nations de Nanaimo, a mené une étude sur la productivité des quinnats (*Oncorhynchus tshawytscha*) juvéniles. Les trois principaux éléments de ce projet annuel sont les suivants : i) dénombrement des juvéniles en dévalaison, ii) surveillance de la croissance des alevins d'écloserie et des alevins sauvages, iii) surveillance des lâchers par les écloseries et interaction entre les alevins d'écloserie et les alevins sauvages dans les cours d'eau. La production a été estimée au moyen d'une trappe à vis sans fin. Des alevins sauvages colorés au brun Bismark ont été relâchés en amont de la trappe; les résultats des recaptures de ces alevins marqués ont été utilisés pour extrapoler les captures à la trappe en vue d'estimer la production totale. La production de quinnats juvéniles pour l'année d'éclosion 1998 a été estimée à un minimum de 25 424 (niveau de confiance à 95 % : 22 822 à 27 966). Les alevins d'écloserie n'ont fourni que des données minimales de recapture. Un total de 1 691 alevins d'écloserie ont été récupérés sur les trois lâchers (9, 12 et 13 mai) effectués pendant que le projet était en cours. Nous pensons que ces alevins d'écloserie ont migré hors du cours d'eau peu après leur libération, et que ceux qui sont restés dans le cours d'eau pendant un certain temps n'ont pas migré vers la trappe avant la fin du projet. L'autre libération d'alevins (28 mai) a eu lieu après la fin du projet. On pense donc qu'il y a peu d'interaction entre les alevins d'écloserie et les alevins sauvages. D'après les registres des écloseries, le total des alevins et des smolts de quinnat libérés en 1999 s'élève à 608 425.

## INTRODUCTION

Chinook salmon (*Oncorhynchus tshawytscha*) have in the last several years shown a decline in stock size in the southern part of the Strait of Georgia and have been a focus of study since then because of their importance to the local fisheries (Farlinger et al. 1990). Three stocks, the Nanaimo, Squamish, and Cowichan, are used to indicate the status of the lower Georgia Strait chinook stock. The objectives of this assessment include: i) quantitatively determining the optimum spawning requirement for chinook salmon (this involves investigations of the factors contributing to juvenile production, interactions between hatchery and wild chinook, and estimation of the spawning escapement and catch attributed to the hatchery and wild components of the total run), and ii) developing guidelines for establishing escapement targets for other B.C. chinook stocks (Nagtegaal et al. 1994a). In 1988, a detailed study of chinook productivity using the three previously mentioned indicator stocks was implemented by Fisheries and Oceans Canada, Pacific Biological Station. Results of these studies could then be used to assess rebuilding strategies and determine the effects of harvest management policies for these stocks.

Prior to this study, research on Nanaimo River chinook stocks was limited to overflight information and standardized swim surveys carried out by the Nanaimo River hatchery in conjunction with the Fishery Officers (Aro 1973). The opportunity then arose in 1995 to implement an extensive adult chinook enumeration study in conjunction with Nanaimo First Nations on the Nanaimo River. A counting fence was then constructed and was in operation from the beginning of August to the end of October. In the spring of 1996, the juvenile portion of this study was initiated. The juvenile portion allowed assessment of: i) the timing and abundance of juvenile chinook out-migrants, ii) the growth of hatchery and naturally-reared juveniles, iii) monitoring hatchery releases, and iv) the interaction between the hatchery and naturally-reared juveniles in the river and in the estuary.

Chinook salmon in the Nanaimo River show three juvenile life history types demonstrated by different ages and size at the time they leave the river and migrate into the ocean (Healey and Jordan 1992; Carl and Healey 1994). The first type migrates to the sea immediately after leaving the spawning gravel and rears in estuarine habitats, the second leaves the river after developing for approximately two months ('90 day smolts'), and the third type enter the sea after rearing in fresh water for about a year. It is believed that these types are created due to subpopulations that spawn in separate areas of the river (Healey 1990).

Production of hatchery chinook fry on the Nanaimo River began in 1990 (Cross et al. 1991). Chinook fry releases have increased since then from 61,474 to 608,425 in 1999. Coded-wire tagged chinook releases began in 1990 where a portion of the hatchery fry released were marked with a coded-wire tag implanted in the nose of the fish. In 1999, no releases were coded-wire tagged. Hatchery release of Nanaimo River chinook fry is generally done in three parts. First is an early release, where 5g pre-smolts are released in the beginning of May just downstream of the Island Highway bridge in the lower river. Second is the lake release, where 6-7g pre-smolts are reared in the hatchery until they reach this point, then are moved to lake net pens situated at the mouth of First Lake. They are then released into the lake in late May. The

third, which is the late release, consists of 6g pre-smolts also released downstream of the Island Highway bridge in late May.

The purpose of this report is to present the results obtained from the downstream fry trapping study conducted in the spring of 1999 and to estimate juvenile production based on these results. Hatchery fish are referred to as those that were spawned and reared in a hatchery setting regardless of parental origin and naturally-reared fish as those that spawned and reared in the river setting.

## METHODS

### STUDY AREA

The Nanaimo River flows into the estuary on the east coast of Vancouver Island, British Columbia, just south of the city of Nanaimo and approximately 80 km north of Victoria (Fig. 1). It flows for approximately 56 km and has a watershed of 830 km<sup>2</sup>. The system includes four small lakes and two storage reservoirs. Flow ranges from about 3 m<sup>3</sup>/sec in the summer to over 400 m<sup>3</sup>/sec during winter freshets and averages about 42 m<sup>3</sup>/sec. The Nanaimo River system supports populations of chinook, coho (*O. kisutch*), pink (*O. gorbuscha*), and chum (*O. keta*) salmon (Aro 1973).

A Community Economic Development Program (CEDP) hatchery is situated alongside the Nanaimo River approximately 8 km upstream from the Nanaimo estuary. The hatchery is managed by the Community Futures Development Corporation of Central Island Society under the auspices of the Habitat and Enhancement Branch of Fisheries and Oceans Canada. The facility began chinook production with adults from the 1979 brood year.

### FISH CAPTURE

During the period of Feb. 19 - May 24, 1999, a 2.4 m diameter rotary screw trap<sup>1</sup> was used to trap salmonid juveniles migrating downstream to the estuary. The trap was placed approximately 5 km upstream of the estuary (Fig. 1) and held in place by galvanized steel cables suspended across the river. The trap was used to fish overnight on Monday, Wednesday, and Friday evenings. After each approximately 12-hour period, the trap was checked and the fish were sampled. On some occasions the trap was set to fish during the day or fished for 24 hours to observe diel movement. When fishing for 24 hours, the trap was still checked every twelve hours to distinguish and observe the differences between day and night-time movement. As well, when Bismarck Brown dyed fry were released above the trap for efficiency estimates, the trap was operated continuously for approximately 3 days to record recapture data.

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<sup>1</sup> Manufactured by E.G. Solutions, Corvallis, Oregon, U.S.A.

All fish collected were enumerated and recorded on data sheets according to species, time period, and capture date. Chinook juveniles were identified as being either hatchery or naturally-reared fry based on length and weight characteristics. As a general rule, the weight and length of hatchery fry at the time of release are substantially larger than that of a naturally-reared fry. No hatchery fish were assumed to be in the river prior to the first release on May 7. The number of adipose-clipped hatchery fish was also recorded. Coho were recorded as being fry, one year, or two year old smolts. Water temperature, flow rate<sup>2</sup>, and weather conditions were also recorded at each sampling time. River discharge information was obtained from Water Survey Canada.

## ABUNDANCE ESTIMATES

Trap efficiency information was used to expand the trap catch to estimate the total number of fish migrating past the trap site. The mark-recapture method was used with chum fry as explained below since few chinook were available. Approximately 300 wild chum fry were stained with Bismarck Brown dye (Ward and VerHoeven 1963) and then released about 500 m upstream from the trap site. The number of stained fish recaptured over subsequent days was recorded. This was repeated four times throughout the study. The proportion of dyed to undyed recaptures was used to obtain trap efficiency data and then used to expand the unmarked fish catch and therefore estimate the total number of fish migrating past the trap site.

Trap efficiency was estimated using:

$$E_{ij} = R_{ij} / M_{ij}$$

where:

E is the estimated trap efficiency at site i and sampling date j

R is the number of marked fish recaptured

M is the number of marked fish released

Inherent in these efficiency tests were the following assumptions:

- i) marking of the fish does not affect short term survival of these fish
- ii) all marked fish released above the trap site migrate downstream past the trap
- iii) marked fish behave the same as unmarked fish
- iv) all recaptured fish were counted

The total number of fish was estimated by:

$$N_i = U_{ij} / E_{ij}$$

<sup>2</sup> Flow Metre, Model 2030R, General Oceanics Inc., 1295 NW 163<sup>rd</sup> St., Miami, Florida, U.S.A.

where:

N is the estimated number of marked fish

U is the catch of unmarked fish in the trap

The estimates of daily fish migration were obtained by taking the mean of the days when the trap was in operation to fill in the days when the trap was not operating. For example, the mean of the total number of fry fished on Monday and Wednesday would be inserted for Tuesday. Twenty-four hour estimates were extrapolated for the parts of the day when the trap was not fishing. The total production number is the sum of the daily catch estimates for the period of study (Nagtegaal et al. 1997)

The adjusted Peterson estimate (Ricker 1975) was used to obtain confidence limits of trap efficiency. A minimum confidence limit was used since there is added uncertainty from irregular trap efficiencies, interpolation of unsampled days, and extrapolation for unsampled parts of the day (Nagtegaal et al. 1995; Candy et al. 1996).

## GROWTH

Length and weight of naturally-reared fry were measured to observe growth. Each sampling time, a sample of fry was taken and their fork length was measured to the nearest mm and weight was measured to the nearest one hundredth of a gram.

Growth information on hatchery fry was obtained from the Nanaimo River hatchery. A sample of 40-50 fry were measured in length and weight periodically prior to release.

## RESULTS

### BIOPHYSICAL CONDITIONS

Over the course of the study, discharge on the Nanaimo River had a few fluctuations but generally decreased from approximately 199 m<sup>3</sup>/s in mid February to about 25.9 m<sup>3</sup>/s in early April and then increased to 69.1 m<sup>3</sup>/s at the end of May (Inland Water Directorate, unpubl.). The mean discharge for February was 95.0 m<sup>3</sup>/s; for March 62.1 m<sup>3</sup>/s; for April 49.4 m<sup>3</sup>/s; for May 58.5 m<sup>3</sup>/s. Flow rates fluctuated from a high of 1.6 m/s to a low of 0.38 m/s. Water temperature increased from 4°C to 10°C (Fig. 6).

### MIGRATION TIMING

Upon completion of the project, a total of 85 naturally-reared chinook juveniles and 1,691 hatchery chinook juveniles had been counted (Table 1). The migration of the chinook juveniles

was observed from Feb. 19 until May 20. No chinook fry were observed until Mar. 19 when one naturally-reared fry was counted. A peak in migration of the naturally-reared fry was observed in early May. The hatchery chinook were all captured between May 11-25. All hatchery releases occurred in May 15, and it is assumed that the hatchery fry either left the river almost immediately after release or they simply had not migrated down to the trap site before the project ended.

## DIEL MIGRATION

Trapping was done for two 24-hour periods approximately every two weeks to determine day-time vs. night-time movement. Chinook, chum, and coho samples were all tabulated to show percent daytime movement (Table 2). As in previous years, approximately 90% of chinook were caught at night. Chum and coho samples showed a slightly lower percentage caught at night.

## HATCHERY RELEASES

The Nanaimo River hatchery had five releases this year, four fall stock releases and one spring stock release. Approximately 608,425 hatchery chinook juveniles were released of which none were coded-wire tagged (Fig. 3). Three of the releases totalling 277,444 occurred during the study period. It can be assumed that the hatchery fry behaved this year much like that of previous years where interaction of hatchery and naturally-reared fry was believed to be minimal (Nagtegaal and Carter 1997). Generally the hatchery fry leave the river shortly after release.

## TRAP EFFICIENCIES AND ABUNDANCE

Trap efficiency tests this year were all conducted using hatchery chinook and chum fry because of the low numbers of naturally-reared chinook migrating past the trap site. Four tests were run; one each on Mar. 10, Mar. 17, Apr. 7, and Apr. 28. The mean efficiency of these tests was found to be 9.5% for hatchery chinook and 7.2% for chum fry (Table 4). Trap efficiency varied considerably during the survey. As water flow decreased, some minor adjustments were made to the position of the trap relative to the main flow, to optimize trapping efficiency. Trap efficiency was calculated for each test and there were significant differences ( $P < 0.05$ ; chi-square test) between consecutive tests (Zar 1984). From previous surveys (Nagtegaal and Carter 1997) both hatchery and naturally-reared fry had similar recovery rates.

Based on the efficiency calculations, the total number of naturally-reared chinook in the Nanaimo River was estimated to be 25,424 (95% confidence limit: 22,822 – 27,966) (Table 1; Fig. 2). The number of hatchery fry that migrated past the trap site was estimated to be 203,896.

## SIZE

The size of naturally-reared chinook fry remained generally the same until the beginning of May at which time both length and weight steadily increased. Length was consistently around 40mm until an increase to a mean of 50 mm was observed in May (Fig. 4). Weight remained around 0.4 gr until May when it increased to a mean of 1.2 gr (Fig. 5). Before release, hatchery fry grew in length from a mean of 55 mm at the end of February to a mean of 75.4mm in May. They increased in weight from a mean of 2.5 gr in February to a mean of 5.6 gr in May. Regardless of which release strategy, the hatchery juveniles were substantially larger than the naturally-reared fry.

## DISCUSSION

Healey (1990) indicated that the majority of juvenile outmigrants in the Nanaimo River move to the estuary in the first few weeks after emergence. It was assumed that the numbers of chinook outmigrants generated from our calculations reflect an estimate of the size of this group. What is not included in these calculations is the number of fry that remain in the river for more than a few weeks. Healey and Jordan (1992) reported that only upper river spawners (Spring stock) produced juveniles (approx. 7.6%) that remained in the river for up to a year ('stream type' life history strategy). Lower river spawners (Fall stock) primarily produced juveniles (> 99%) that immediately migrate to the estuary ('ocean type' life history strategy). It was assumed that the results of this study primarily reflect the fry production of the fall stock.

The greatest potential for significant error in the abundance estimates would be from the efficiency tests. No obvious problems were observed during these tests and all dyed fish used in the tests were in good condition at the time of release. If the dyeing reduced fish health and therefore caused the trap efficiency to be biased high, then abundance would be underestimated. If the dyed fish that were released upstream were not uniformly distributed in the river when they moved past the trap site, this could have also caused the trap efficiency tests to be incorrect. No further tests were conducted to examine these potential sources of error. Roper and Scarnecchia (1996) reported that under low flow conditions, larger hatchery fish were more likely to avoid being caught by a rotary screw trap than smaller naturally-reared fish. When such trap efficiency data were the basis for expansion to total abundance, it was emphasized that the results could be misleading if efficiencies were not measured independently for hatchery and naturally-reared fish. We were convinced that neither of these possibilities caused any problems since we maintained the trap in higher flow conditions.

## EGG TO FRY SURVIVAL

Escapement of fall chinook to the Nanaimo River in 1998 was estimated to be 1054 of which 48% were females. Based on swim survey results (P. Preston, 271 Pine Street, Nanaimo,

B.C., V9R-2B7, pers. comm.), the spring stock was estimated to be 200 adult chinook of which approximately 48% were considered to be females. According to hatchery broodstock records, average fecundity of the 1998 chinook fall stock was calculated to be 4,485 eggs per female and for the spring stock it was calculated to be 3,831 eggs per female. Based on these data, we estimated egg deposition to be a little less than two million (Table 5). Egg to fry survival for the 1998 brood was estimated to be 1.41% (95% CL: 1.27% - 1.38%).

These egg to fry survival rates are both low compared to last year in the Nanaimo River (Nagtegaal and Carter 1997). However, they resemble the Cowichan River egg to fry survival rates of 1.3% - 3.4% in 1995 and 1996 (Candy et al. 1996). As well, these rates were considered conservative since according to Healey (1990) approximately 8% of the progeny of upper river spawners rear in the upper river for up to a year.

Reproductive success depends in part on egg burial depth and the depth of scouring during peak winter discharge (Montgomery et al. 1995). Discharge levels on the Nanaimo River this past fall (Fig. 7) indicate that significant scouring must have occurred due to higher than average flows.

## SIZE

Since the mean size of naturally-reared outmigrant chinook fry only marginally increased over the course of the study until May, we assumed that we were likely not monitoring fry growth by measuring and weighing fry at the trap site. During the entire sampling period we were likely trapping only juveniles that had emerged and immediately moved downstream to the estuary. Our length and weight measurements simply reflect the size of juveniles moving downstream. By the end of May, some larger fry were caught in the trap and were likely from a portion of the population that remained in the river above the trap for some weeks prior to migrating downstream, as observed in previous studies (Healey and Jordan 1992; Healey et al. 1977). These larger fry may be indicative of the '90-day' life history strategy described by Healey (1991) and likely represent some of the progeny from upper river spawners. It could also be that some of the larger fry caught later were actually hatchery fry from the late release.

## INTERACTION

It was assumed that chinook juveniles behaved like those in previous years, which showed minimal interaction. Since the study period overlapped with only one hatchery release, the remaining three were not monitored and therefore no comment could be made in regards to the interaction between these late hatchery releases and the naturally-reared fry.

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Table 1. Naturally-reared and hatchery chinook rotary trap catch data at the trap site, Nanaimo River, 1999.

Naturally-reared:					
Date	Observed	Missing cells Interpolated	24-hour Estimates	Extrapolated Estimates	Cumulative Total
19-Feb				0	0
26-Feb				0	0
27-Feb				0	0
28-Feb				0	0
29-Feb				0	0
01-Mar				0	0
02-Mar				0	0
03-Mar				0	0
04-Mar				0	0
05-Mar				0	0
06-Mar				0	0
07-Mar				0	0
08-Mar				0	0
09-Mar				0	0
10-Mar				0	0
11-Mar				0	0
12-Mar				0	0
13-Mar				0	0
14-Mar				0	0
15-Mar				0	0
16-Mar				0	0
17-Mar				0	0
18-Mar				0	0
19-Mar	1			1	112
20-Mar			2	2	224
21-Mar			2	2	224
22-Mar			2	2	224
23-Mar			2	2	224
24-Mar			2	2	224
25-Mar	3			3	336
26-Mar			2	2	224
27-Mar	1			1	112
28-Mar			1	1	112
29-Mar			1	1	112
30-Mar	1			1	112
31-Mar			2	2	224
01-Apr			2	2	224
02-Apr			2	2	224
03-Apr	4			4	448
04-Apr			3	3	336
05-Apr			3	3	336
06-Apr			3	3	336
07-Apr			3	3	336
08-Apr	2			2	224
09-Apr	5			6	560
10-Apr			3	3	336
11-Apr			3	3	336
12-Apr			3	3	336

Table 1 (cont'd)

Date	Observed	Missing cells Interpolated	24-hour Estimates	Extrapolated Estimates	Cumulative Total
13-Apr	1			112	6608
14-Apr			1	112	6720
15-Apr	1		1	112	6832
16-Apr		3	3	336	7168
17-Apr	7		8	784	7952
18-Apr		3	3	336	8288
19-Apr		3	3	336	8624
20-Apr	1		1	112	8736
21-Apr		1	1	112	8848
22-Apr	2		2	224	9072
23-Apr		7	8	784	9856
24-Apr	11		12	1232	11088
25-Apr		9	10	1008	12096
26-Apr		9	10	1008	13104
27-Apr	6		7	672	13776
28-Apr		6	7	672	14448
29-Apr	6		7	672	15120
30-Apr		8	9	896	16016
01-May	9		10	1008	17024
02-May		12	13	1344	18368
03-May		12	13	1344	19712
04-May	15		17	1680	21392
05-May		9	10	1008	22400
06-May	3		3	336	22736
07-May		2	2	224	22960
08-May		2	2	224	23184
09-May		2	2	224	23408
10-May		2	2	224	23632
11-May	1		1	112	23744
12-May		1	1	112	23856
13-May	1		1	112	23968
14-May		1	1	112	24080
15-May		1	1	112	24192
16-May		1	1	112	24304
17-May		1	1	112	24416
18-May		1	1	112	24528
19-May	2		2	224	24752
20-May		2	2	224	24976
21-May		2	2	224	25200
22-May	2		2	224	25424
23-May			0	0	25424
24-May					
Total:	85			25424	

Table 1 (cont'd)

## Hatchery-reared:

Date	Observed	Missing cells Interpolated	24-hour Estimates	Extrapolated Estimates	Cumulative Total
11-May	235		263	13160	13160
12-May		134	150	7504	20664
13-May	33		37	1848	22512
14-May	1100		1232	61600	84112
15-May		562	629	31472	115584
16-May		562	629	31472	147056
17-May		562	629	31472	178528
18-May	25		28	1400	179928
19-May	88		99	4928	184856
20-May	172		193	9632	194488
21-May		92	103	5152	199640
22-May	13		15	728	200368
23-May		19	21	1064	201432
24-May		19	21	1064	202496
25-May	25		28	1400	203896
Total:	1691			203896	

Table 2. Diel migration pattern observed for salmon fry, Nanaimo River, 1999.

Date	Day Movement			Night Movement			% Daytime Movement		
	chinook	chum	coho	chinook	chum	coho	chinook	chum	coho
11-Mar	8	37		30	99	0	21.05	27.21	
12-Mar	0	87		1	135	0	0.00	39.19	
18-Mar	2	79		14	431	0	12.50	15.49	
19-Mar	0	262		3	534	2	0.00	32.91	0.00
8-Apr	2	2588		15	14983	0	11.76	14.73	
9-Apr	1	1828	1	4	11684	1	20.00	13.53	50.00
29-Apr	0	685	6	14	4466	24	0.00	13.30	20.00
30-Apr	1	1397	23	8	4933	67	11.11	22.07	25.56
<b>TOTAL:</b>	<b>14</b>	<b>6963</b>	<b>30</b>	<b>89</b>	<b>37265</b>	<b>94</b>	<b>9.55</b>	<b>22.30</b>	<b>23.89</b>

Table 3. Juvenile chinook releases, Nanaimo hatchery, 1990-1999.

Tag Code	BY	Number Tagged	Number Release	CWT % Mark	Weigh (gram)	Release Date ddmmyy:ddmmyy	Release Site
26303	89	27171	74720	36.4	6.5	12Jun90:14Jun90	0126-NANAIMO RIVER
26304	89	26837	74720	35.9	5.4	:07May90	0126-NANAIMO RIVER
26305	89	27074	50174	54.0	6.7	28May90:29May90	0126-NANAIMO RIVER
26308	89	26352	49452	53.3	6.7	28May90:29May90	0126-NANAIMO RIVER
21141	90	26389	26389	100.0	6.6	17May91:17May91	0126-NANAIMO RIVER
21142	90	27006	27006	100.0	5.4	10May91:10May91	0126-NANAIMO RIVER
21143	90	26199	26199	100.0	6.5	31May91:31May91	0126-NANAIMO RIVER
26156	90	10645	19997	53.5	5.7	24May91:24May91	0126-NANAIMO RIVER
26157	90	10799	20052	53.9	5.7	24May91:24May91	0126-NANAIMO RIVER
180523	91	27353	112904	24.2	4.8	21May92:27May92	0126-NANAIMO RIVER
180524	91	27443	112995	24.3	4.8	21May92:27May92	0126-NANAIMO RIVER
180525	91	27564	193704	14.2	3.3	26May92:28May92	0126-NANAIMO RIVER
180526	91	27406	193546	14.2	3.3	26May92:28May92	0126-NANAIMO RIVER
180548	92	26234	112389	23.3	6.0	04May93:26May93	0126-NANAIMO RIVER
180549	92	26399	113091	23.3	6.0	04May93:26May93	0126-NANAIMO RIVER
181013	92	27361	118399	23.1	6.0	04May93:26May93	0126-NANAIMO RIVER
181014	92	27103	117286	23.1	6.0	04May93:26May93	0126-NANAIMO RIVER
181032	93	25157	49954	50.4	6.0	02May94:02May94	0126-NANAIMO RIVER
181033	93	25106	66474	37.8	6.7	12May94:12May94	0126-NANAIMO RIVER
181034	93	25130	66538	37.8	6.7	12May94:12May94	0126-NANAIMO RIVER
181035	93	24896	187781	13.3	6.1	24May94:24May94	0126-NANAIMO RIVER
181323	94	25286	96450	26.2	6.6	24May95:24May95	0126-NANAIMO RIVER
181324	94	25147	95919	26.2	6.6	24May95:24May95	0126-NANAIMO RIVER
182159	94	25347	111844	22.7	5.5	04May95:04May95	0126-NANAIMO RIVER
180355	95	24978	38928	64.2	6.3	09May96:09May96	2726-FIRST LAKE/GSVI
180356	95	25003	38967	64.2	6.3	09May96:09May96	2726-FIRST LAKE/GSVI
180357	95	25137	310220	8.1	7.0	29May96:30May96	0126-NANAIMO RIVER
180358	95	25086	216293	11.6	5.7	01May96:02May96	0126-NANAIMO RIVER
181716	96	10025	83484	12.0	4.9	20May97:21May97	0126-NANAIMO RIVER
182306	96	9132	36827	24.8	5.4	05May97:05May97	0126-NANAIMO RIVER
182746	96	27690	230592	12.0	4.9	20May97:21May97	0126-NANAIMO RIVER
182747	96	28525	115033	24.8	5.4	05May97:05May97	0126-NANAIMO RIVER
183452	96	10052	42755	23.5	6.2	20May97:20May97	2726-FIRST LAKE/GSVI
183453	96	10077	42861	23.5	6.2	20May97:20May97	2726-FIRST LAKE/GSVI
183454	96	10095	42937	23.5	6.2	20May97:20May97	2726-FIRST LAKE/GSVI
183455	96	10050	42746	23.5	6.2	20May97:20May97	2726-FIRST LAKE/GSVI
182408	97	10050	15610	64.4	6.0	26May98:26May98	0126-NANAIMO RIVER
183220	97	25240	70000	36.1	6.7	07May98:07May98	2726-FIRST LAKE/GSVI
183221	97	25173	99099	25.4	6.0	15May98:15May98	2726-FIRST LAKE/GSVI
183222	97	24824	24824	100.0	15.5	23Jul98:23Jul98	0126-NANAIMO RIVER
183223	97	28252	43881	64.4	6.0	26May98:26May98	0126-NANAIMO RIVER
NOCN	98	0	24991	0	5.3	09May99:09May99	0126-NANAIMO RIVER
NOCN	98	0	252453	0	5.3	12May99:12May99	0126-NANAIMO RIVER
NOCN	98	0	165386	0	5.4	28May99:28May99	0126-NANAIMO RIVER
NOCN	98	0	165595	0	5.6	28May99:28May99	2726-FIRST LAKE/GSVI
<b>TOTALS</b>		<b>930792</b>	<b>3612939</b>				

Tag Code: refers to a coded-wire tag code

BY: refers to brood year

Data compiled from the Mark Recovery Program (MRP) database  
(Kuhn 1998)

Table 4. Trap efficiency data for the rotary screw trap, Nanaimo River, 1999.

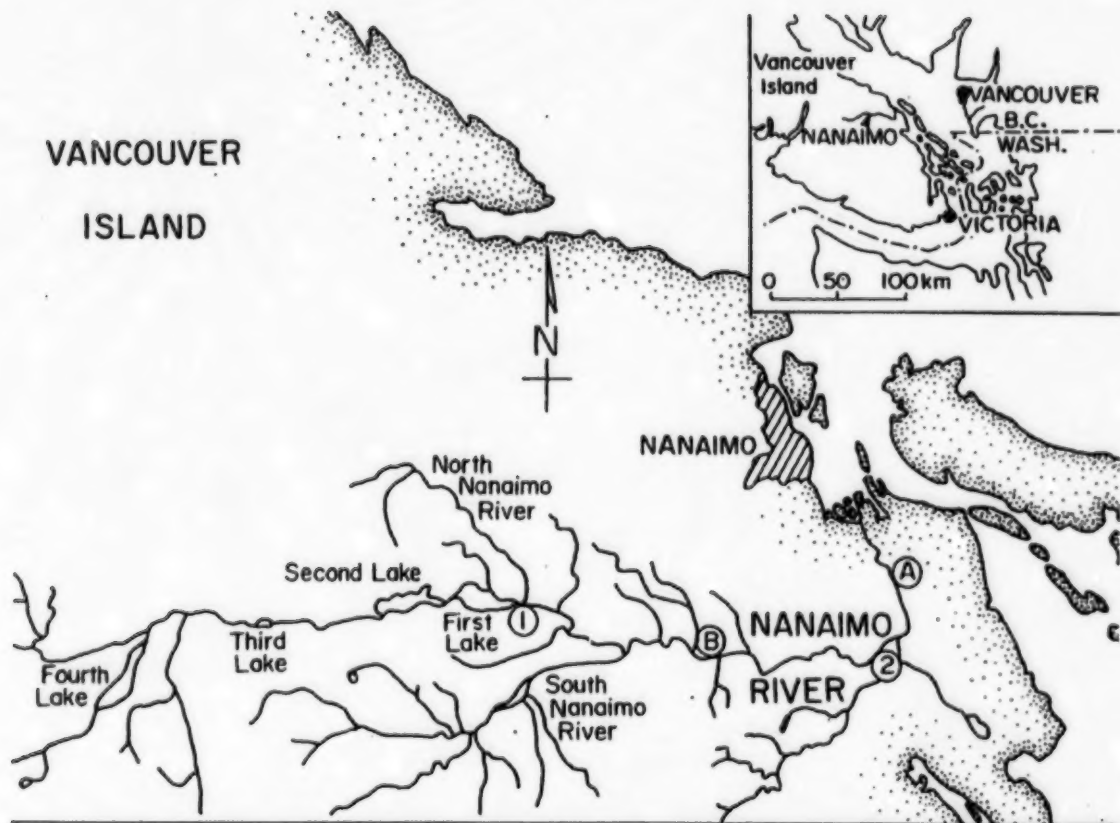
Date	Releases		Recoveries		Efficiency	
	Hatchery Chinook	Chum	Hatchery Chinook	Chum	Hatchery Chinook	Chum
10-Mar	548	95	41	3	7.5%	3.2%
17-Mar	156	169	18	3	11.5%	1.8%
7-Apr	112	198	14	30	12.5%	15.2%
28-Apr	122	193	8	17	6.6%	8.8%
TOTAL	938	655	81	53	9.5%	7.2%

Table 5. Chinook egg to fry survival estimates<sup>3</sup>, 1998 brood year, Nanaimo River.

Brood Year	Escapement Estimate	% Females	Estimated Females	Fecundity	Estimated Egg Production	Estimated Fry	Egg/Fry Survival
1998							
Fall Stock	808	45%	363.6	4485	1,630,746		
Spring Stock	100	45%	45	3831	172,395		
Total Stock					1,803,141	25,424	1.41%
					Minimum:	22,882	1.27%
					Maximum:	24,950	1.38%

<sup>3</sup> Escapement estimate based on fence count and swim survey data.

Fecundity information provided from Nanaimo Hatchery broodstock data



**Legend:**

- 1 Upper river hatchery release site
- 2 Lower river hatchery release site
- A Enumeration fence site and Downstream trapping site

Fig. 1. Trap sampling and hatchery release sites on the Nanaimo River.

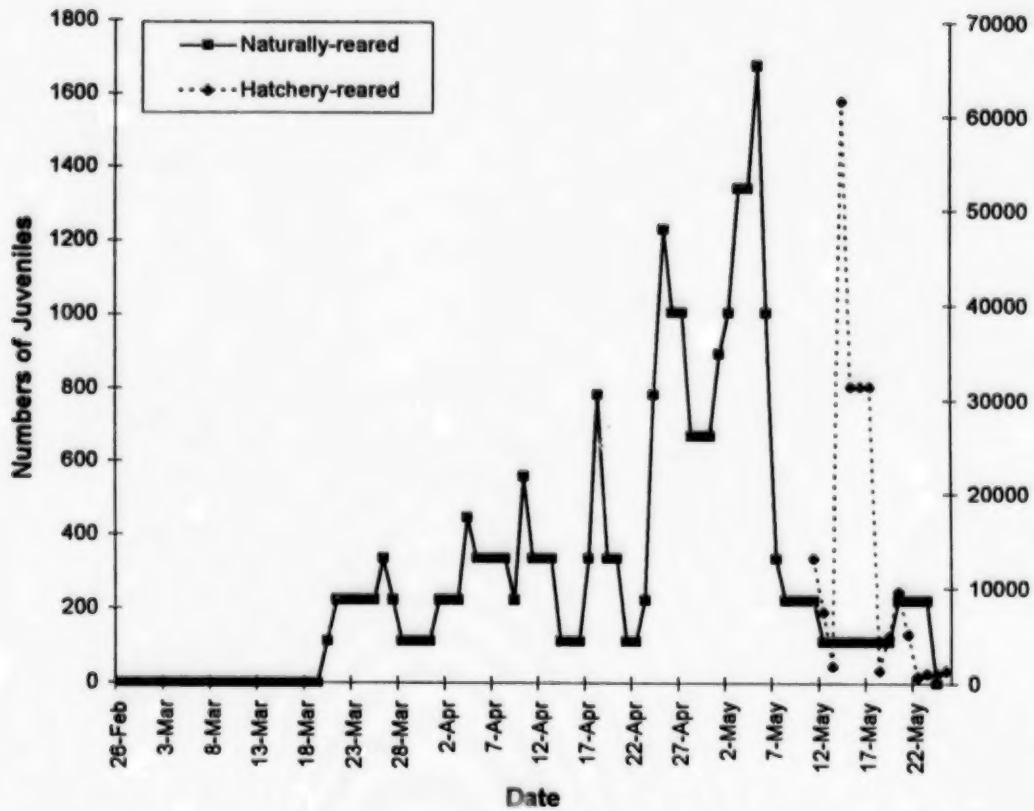


Fig. 2. Expanded estimates of juvenile chinook migration by day at the trap site, Nanaimo River, 1999.

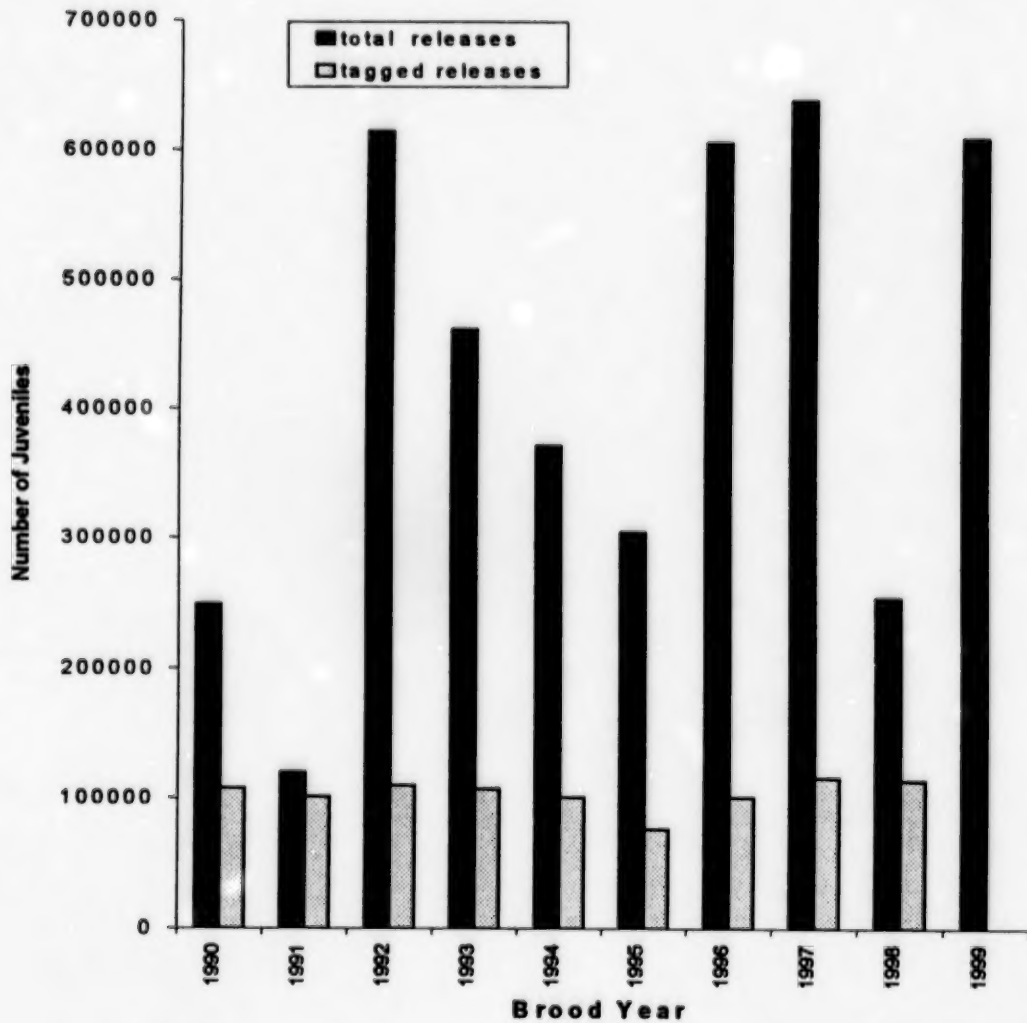


Fig. 3. Hatchery chinook released into the Nanaimo River as fry (3 gm) and as pre-smolts (6 gm).

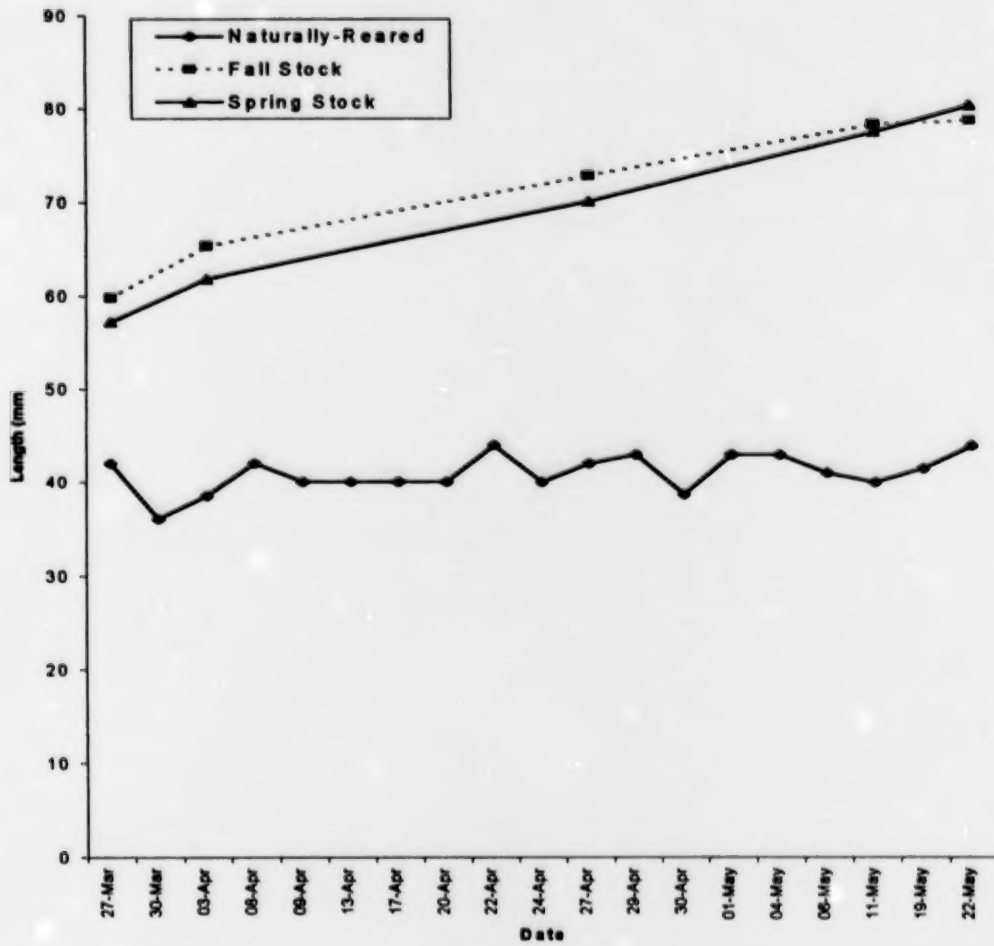


Fig. 4. Mean length of chinook fry by day, Nanaimo River, 1999.

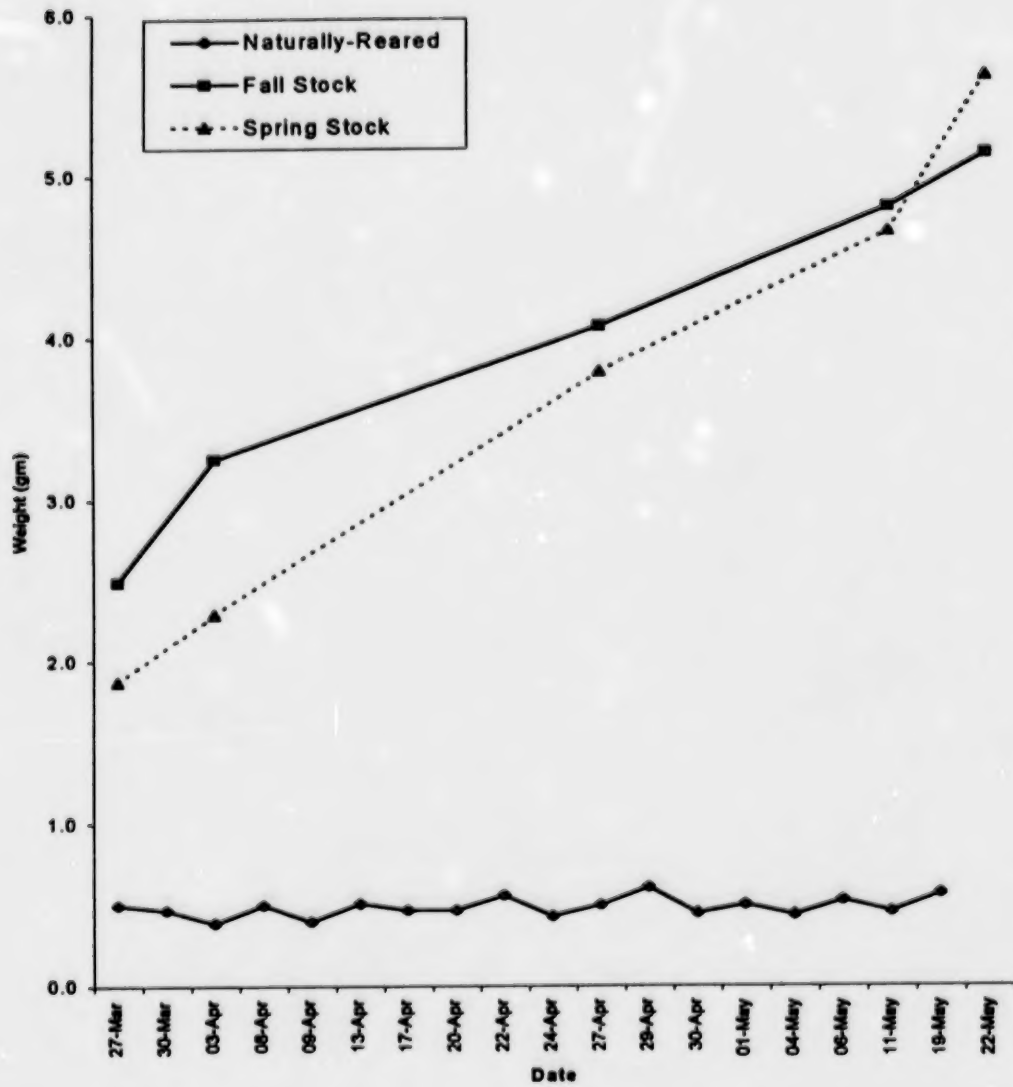


Fig. 5. Mean weight of chinook fry by day, Nanaimo River, 1999.

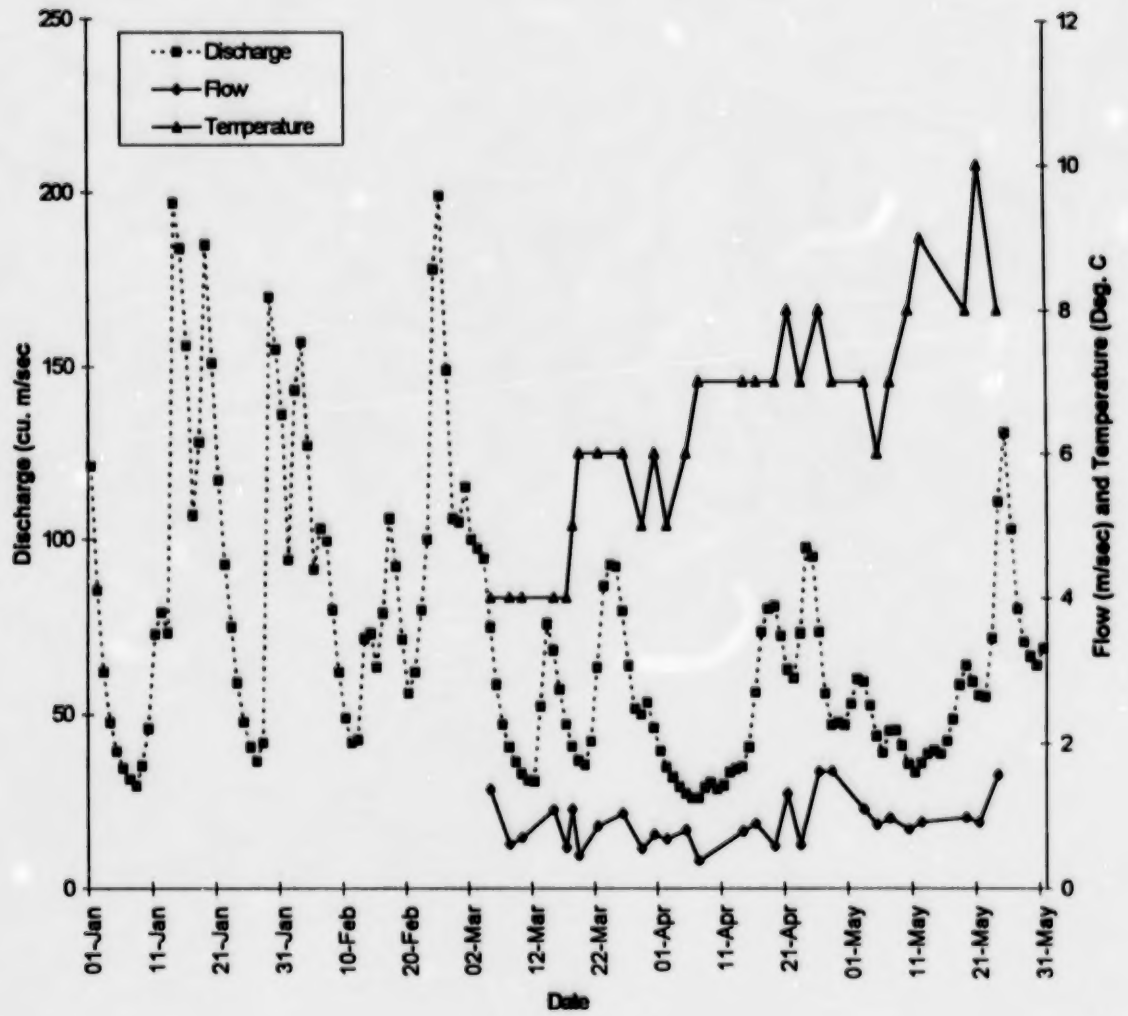


Fig. 6. Discharge, flow and water temperature recorded for the Nanaimo River, 1999.

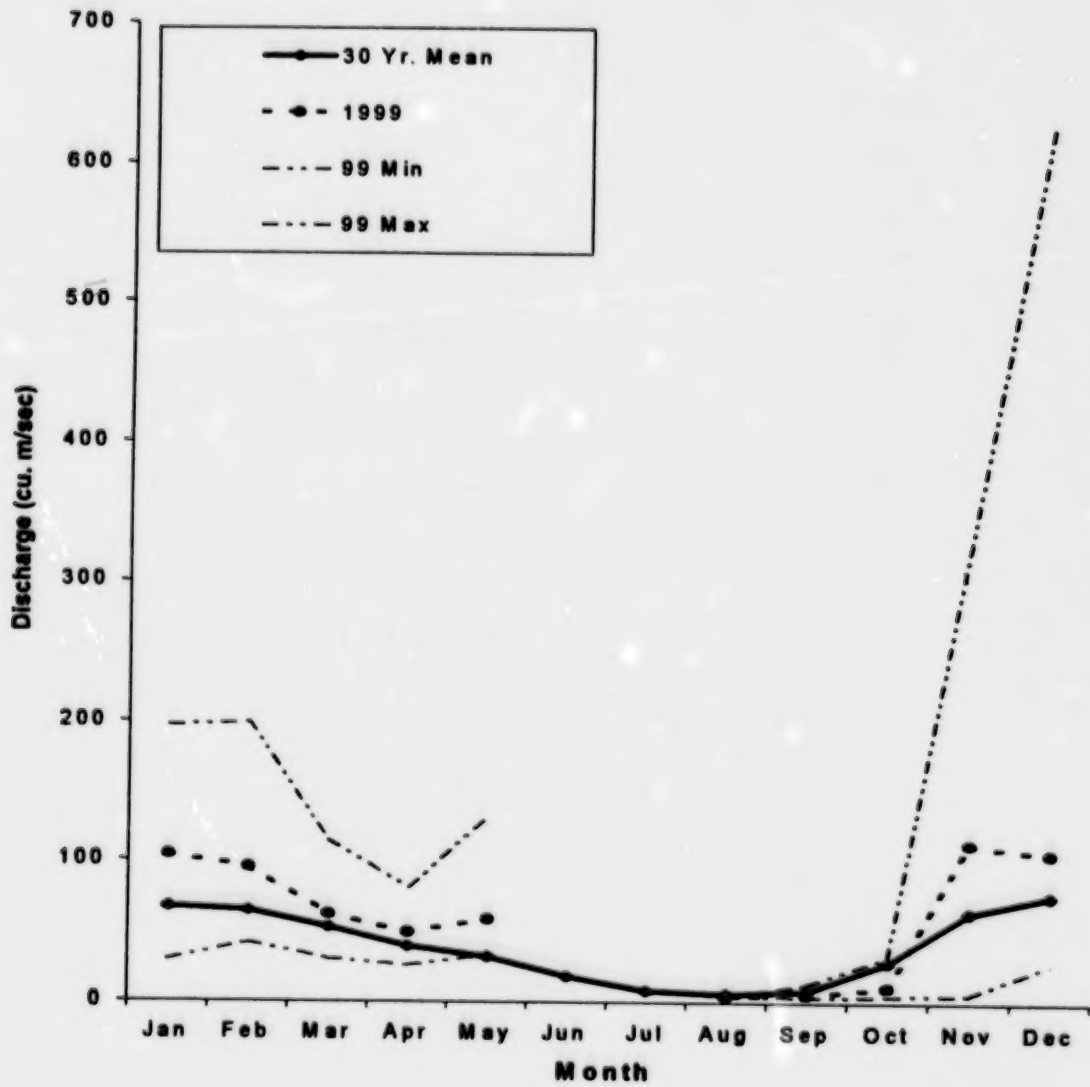


Fig. 7. Nanaimo River discharge compared to 30 year mean from August 1999 to May 1999.